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(71) Applicant (for all designated States except US): ASTRAZENECA AB [SE/SE]; S-151 85 Södertälje (SE). (72) Inventors; and (75) Inventors/Applicants (for US only): TUCKER, Howard [GB/GB]; Alderley Park, Macclesfield, Cheshire SK10 4TG (GB). LARGE, Michael, Stewart [GB/GB]; Alderley Park, Macclesfield, Cheshire SK10 4TG (GB). OLDFIELD, John [GB/GB]; Alderley Park, Macclesfield, Cheshire SK10 4TG (GB). JOHNSTONE, Craig [GB/GB]; Alderley Park, Macclesfield, Cheshire SK10 4TG (GB). EDWARDS, Philip, Neil [GB/GB]; Alderley Park, Macclesfield, Cheshire SK10 4TG (GB). (74) Agent: TIERNEY, Francis, John; AstraZeneca, Global Intellectual Property, P.O. Box 272, Mereside, Alderley Park, Macclesfield, Cheshire SK10 4GR (GB).		Published <i>With international search report.</i>	
(54) Title: ACYLATED AMINOACETONITRILES AS CYSTEINE PROTEASE INHIBITORS			
<p style="text-align: center;">(I)</p>			
<p>(57) Abstract</p> <p>A compound of formula (I): wherein R¹, R², R³ and Ar are defined; a composition comprising a compound of formula (I) and a carrier or diluent; a compound of formula (I) for use as a medicament; the use of a compound of formula (I) in the manufacture of a medicament for use in the inhibition of a cysteine protease in a warm blooded animal; the use of a compound of formula (I) in the manufacture of a medicament for use in the treatment of chronic obstructive pulmonary disease in a warm blooded animal; and a method of treating a Cathepsin L or Cathepsin S mediated disease state in mammals which comprises administering to a mammal in need of such treatment an effective amount of a compound of formula (I).</p>			

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ACYLATED AMINOACETONITRILES AS CYSTEINE PROTEASE INHIBITORS

The present invention relates to compounds that are cysteine protease inhibitors and in particular compounds that are Cathepsin L inhibitors and or Cathepsin S inhibitors especially 5 Cathepsin S inhibitors. The invention further relates to processes for their preparation, to intermediates useful in their preparation, to their use as therapeutic agents, to pharmaceutical compositions containing them and to a method of treating a Cathepsin L or Cathepsin S mediated disease state.

Cysteine proteases are enzymes important in normal cell physiology, but they are also 10 associated with several disease states including inflammation, metastasis, tissue damage following myocardial infarction, bone resorption and muscle wasting in dystrophic diseases.

Cathepsins B, H, K, L, N and S are cysteinyl proteases involved in normal protein degradation and are normally located in the lysosomes of cells. However, when these enzymes are found outside the lysosomes they have been implicated as playing a causative role in a 15 number of disease states including bone resorption disease such as osteoporosis.

The number of people living to an old age has increased dramatically in recent years. This has been marked by an increase in the number of people having osteoporosis and other 20 diseases associated with old age. Osteoporosis is accompanied by a high incidence of bone fracture resulting in many aged patients being confined to their beds. There is therefore a great need for a pharmaceutical composition to treat or prevent this disease.

Living bone is continuously being remodelled and replenished by the process of resorption and deposition of the protein matrix and calcium minerals. These events are facilitated by the osteoclast, which has the ability to degrade and demineralise the bone, and the osteoblast which is responsible for new bone generation. In normal situations these 25 processes are intimately linked resulting in little alteration of bone mass. However, pathological conditions exist in which there is an imbalance between their activities resulting in increased degradation and demineralisation of bone and the development of fragile and/or brittle bone structure, as seen during osteoporosis. While the exact mechanism for this resorption is not known, increased osteoclast activity, as realised by increased proteolytic 30 activity, is a contributing factor, and selective inhibition of proteolytic action may result in the

arrest or reversal of bone loss. The lysosomal cysteine proteinases, Cathepsins B, H, K, L, N and S have been postulated as the proteinases that are responsible for osteoclast bone resorption, because of their ability to degrade insoluble type I collagens at low pH.

Cathepsins B, H, K, L, N and S have been further implicated as playing a causative role

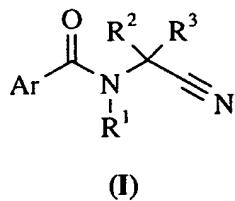
5 in other diseases such as rheumatoid arthritis, osteoarthritis, tumour metastasis, pneumocystitis, Crithidia fusciculata, malaria, trypanosoma brucei brucei, schistosomiasis, periodontal disease, metachromatic leukodystrophy and muscular dystrophy. Cathepsins B, H, K, L, N and S, either alone or together, have also been implicated as playing a causative role in chronic obstructive pulmonary disease (COPD).

10 In recent years a number of synthetic inhibitors of cysteine proteases have been disclosed. US 5,055,451 discloses a series of peptidyl methyl ketones as thiol protease inhibitors; WO 95/15749 discloses peptidyl ketones with heterocyclic leaving groups as cysteine protease inhibitors; the *in vivo* inhibition of Cathepsin B by peptidyl (acyloxy) methyl ketones was discussed in *J. Med. Chem.* 1994, 37, 1833-40 and these types of compounds as 15 inhibitors of cysteine protease inhibitors were also discussed in *J. Am. Chem. Soc.*, 1988, 110, 4429-4431; peptidyl diazomethyl ketones as specific inactivators of thiol proteinases was discussed in *J. Biol. Chem.*, 1981, 256, 4, 1923-8 and in *Methods in Enzymology*, 1981, 80, 820-5; the inhibiting activities of 1-peptidyl-2-haloacetyl hydrazines towards Cathepsin B and calpains was discussed in *Eur. J. Med. Chem.*, 1993, 28 297-311 and peptidyl fluoromethyl 20 ketones as inhibitors of Cathepsin B and the implication for treatment of Rheumatoid arthritis was discussed in *Biochemical Pharmacology*, 1992, 44, 6, 1201-7. Thus, there is a great need for a specific cysteine protease inhibitor, especially a Cathepsin L inhibitor or a Cathepsin S inhibitor.

The present invention discloses compounds with inhibitory activity of cysteine 25 proteases and in particular of Cathepsin L and or Cathepsin S. The compounds of the invention are also useful in the treatment of chronic obstructive pulmonary disease (COPD).

Accordingly the present invention provides a compound of formula (I):

3



wherein

- Ar** is (optionally substituted phenylC₁₋₆alkyl)₂CH-, optionally substituted phenyl,
 5 optionally substituted naphthyl or an optionally substituted heteroaryl ring, said optional substituents being chosen from one or more of halo, C₁₋₆alkoxy, C₁₋₆alkyl, nitro, C₁₋₆alkanoylamino, trifluoromethyl, hydroxy, trifluoromethoxy, cyano, C₁₋₆alkanoyl, C₁₋₆alkanoyloxy, amino, C₁₋₆alkylamino, (C₁₋₆alkyl)₂amino, carboxy, carbamoyl, N-(C₁₋₆alkyl)carbamoyl, N,N-(C₁₋₆alkyl)₂carbamoyl, C₁₋₆alkoxycarbonyl, mercapto,
 10 C₁₋₆alkylsulphonyl, C₁₋₆alkylsulphinyl, C₁₋₆alkylsulphonyl, sulphamoyl, N-(C₁₋₆alkyl)sulphamoyl, N,N-(C₁₋₆alkyl)₂sulphamoyl, aminoC₁₋₆alkyl, N-(C₁₋₆alkyl)aminoC₁₋₆alkyl, (C₁₋₆alkyl)₂aminoC₁₋₆alkyl, R⁵S-, R⁵C(O)- or R⁵CH₂-; R⁵ is phenyl which is optionally substituted by one or more groups chosen from C₁₋₆alkyl, halo, trifluoromethyl, hydroxy, trifluoromethoxy, cyano, C₁₋₆alkoxy, C₁₋₆alkanoyl, C₁₋₆alkanoyloxy,
 15 amino, C₁₋₆alkylamino, (C₁₋₆alkyl)₂amino, C₁₋₆alkanoylamino, nitro, carboxy, carbamoyl, N-(C₁₋₆alkyl)carbamoyl, N,N-(C₁₋₆alkyl)₂carbamoyl, C₁₋₆alkoxycarbonyl, mercapto, C₁₋₆alkylsulphonyl, C₁₋₆alkylsulphinyl, C₁₋₆alkylsulphonyl, sulphamoyl, N-(C₁₋₆alkyl)sulphamoyl or N,N-(C₁₋₆alkyl)₂sulphamoyl;

R¹ is H or C₁₋₆alkyl;

- 20 R² is H, C₁₋₆alkyl (optionally substituted with one or more hydroxy, C₁₋₆alkylsulphonyl, C₁₋₆alkylsulphinyl, C₁₋₆alkylsulphonyl, R⁴, R⁴C₁₋₆alkylsulphonyl, R⁴C₁₋₆alkylsulphinyl or R⁴C₁₋₆alkylsulphonyl), C₁₋₆alkoxy (optionally substituted with one or more halogen, C₂₋₆alkenyl, C₂₋₆alkynyl, R⁴, R⁴C₂₋₆alkenyl, R⁴C₂₋₆alkynyl or Het), C₂₋₆alkenyl, C₂₋₆alkynyl, C₁₋₆alkoxycarbonyl, carbamoyl, N-(C₁₋₆alkyl)carbamoyl, N,N-(C₁₋₆alkyl)₂carbamoyl, R⁴-,
 25 R⁴S-, R⁴C₁₋₆alkylsulphonyl, N-(R⁴C₁₋₆alkyl)carbamoyl, N-(HetC₁₋₆alkyl)carbamoyl, C₁₋₆alkanoylamino, C₁₋₆alkylsulphonyl, C₁₋₆alkylsulphinyl or C₁₋₆alkylsulphonyl; R⁴ is optionally substituted phenyl, or an optionally substituted 5 or 6 membered heteroaryl ring, said optional substituents on R⁴ being chosen from one or more of C₁₋₆alkyl, halo,

- trifluoromethyl, hydroxy, trifluoromethoxy, cyano, C₁₋₆alkoxy, C₁₋₆alkanoyl, C₁₋₆alkanoyloxy, amino, C₁₋₆alkylamino, (C₁₋₆alkyl)₂amino, C₁₋₆alkanoylamino, nitro, carboxy, carbamoyl, N-(C₁₋₆alkyl)carbamoyl, N,N-(C₁₋₆alkyl)₂carbamoyl, C₁₋₆alkoxycarbonyl, mercapto, C₁₋₆alkylsulphanyl, C₁₋₆alkylsulphinyl, C₁₋₆alkylsulphonyl, sulphonamoyl,
- 5 N-(C₁₋₆alkyl)sulphonamoyl or N,N-(C₁₋₆alkyl)₂sulphonamoyl, wherein two such adjacent groups may join to form a 6-membered saturated, partially saturated or unsaturated ring;
- Het is a fully saturated monocyclic 5 - 8 membered heterocyclic ring, with up to 4 ring heteroatoms; and
- R^3 is H or C₁₋₆alkyl;
- 10 or a pharmaceutically acceptable salt thereof.
- In this specification the term 'alkyl' includes straight chained and branched structures and ring systems. For example, C₁₋₆alkyl includes propyl, isopropyl, t-butyl, cyclopropyl and cyclohexyl. However, references to individual alkyl groups such as 'propyl' are specific for the straight chained version only, references to individual branched chain alkyl groups such as
- 15 'isopropyl' are specific for the branched chain version only and references to individual cycloalkyl groups such as cyclohexyl are specific to the cyclic groups only.
- A similar convention applies to other radicals, for example "aminoC₁₋₆alkyl" includes 1-aminoethyl and 2-aminoethyl.
- The term "halo" refers to fluoro, chloro, bromo and iodo.
- 20 "Het" means, unless otherwise further specified, a fully saturated monocyclic 5 - 8 membered heterocyclic ring, with up to 4 ring heteroatoms. Examples of heteroatoms include nitrogen, oxygen and sulphur. Examples of "Het" include pyrrolidinyl, imidazolidinyl, pyrazolidinyl, piperidyl, triazole (especially 1,2,3-triazole), piperazinyl and morpholinyl.
- Examples of "Het" include pyrrolidinyl, imidazolidinyl, pyrazolidinyl, piperidyl, piperazinyl
- 25 and morpholinyl.
- "Heteroaryl ring" means, unless otherwise further specified, a monocyclic- or bicyclic- 5-12 membered ring that contains some degree of unsaturation, with up to five ring heteroatoms selected from nitrogen, oxygen and sulphur. Examples of "heteroaryl ring" include thienyl, furyl, imidazolyl, thiazolyl, pyrimidinyl, pyridinyl, pyrrolyl, pyrazolyl, indolyl,
- 30 benzimidazolyl, benzothiazolyl, quinolyl and isoquinoliny. Examples of "5- or 6- membered

heteroaryl ring" include thienyl, furyl, imidazolyl, thiazolyl, pyrimidinyl, pyridinyl, pyrrolyl and pyrazolyl.

Examples of "C₁₋₆alkanoyloxy" are acetoxy and propionyloxy. Examples of "C₁₋₆alkoxycarbonyl" include methoxycarbonyl, ethoxycarbonyl, *n*- and *t*-butoxycarbonyl.

- 5 Examples of "C₁₋₆alkoxy" include methoxy, ethoxy and propoxy. Examples of "C₁₋₆alkanoylamino" include formamido, acetamido and propionylamino. Examples of "C₁₋₆alkylsulphanyl" include methylthio and ethylthio. Examples of "C₁₋₆alkylsulphinyl" include methylsulphinyl and ethylsulphinyl. Examples of "C₁₋₆alkylsulphonyl" include mesyl and ethylsulphonyl. Examples of "C₁₋₆alkanoyl" include acetyl and propionyl. Examples of "C₁₋₆alkylamino" include methylamino and ethylamino. Examples of "N,N-(C₁₋₆alkyl)₂amino" include *N,N*-dimethylamino, *N,N*-diethylamino and *N*-ethyl-*N*-methylamino. Examples of "C₂₋₆alkenyl" are vinyl, allyl and 1-propenyl. Examples of "C₂₋₆alkynyl" are ethynyl, 1-propynyl and 2-propynyl. Examples of "N-(C₁₋₆alkyl)sulphamoyl" are *N*-methylsulphamoyl and *N*-ethylsulphamoyl. Examples of "N,N-(C₁₋₆alkyl)₂sulphamoyl" are
- 10 15 *N,N*-dimethylsulphamoyl and *N,N*-diethylsulphamoyl. Examples of "N-(C₁₋₆alkyl)carbamoyl" are methylaminocarbonyl and ethylaminocarbonyl. Examples of "N,N-(C₁₋₆alkyl)₂carbamoyl" are *N,N*-dimethylaminocarbonyl and *N,N*-diethylaminocarbonyl. Examples of "N-(C₁₋₆alkyl)aminoC₁₋₆alkyl" are 2-*N*-methylaminoethyl and 3-*N*-ethylaminopropyl. Examples of "N,N-(C₁₋₆alkyl)₂aminoC₁₋₆alkyl" are 2-(*N,N*-dimethylamino)ethyl and
- 20 25 3-(*N,N*-diethylamino)propyl. Examples of "R⁴C₁₋₆alkylsulphanyl" include R⁴methylthio and 2-R⁴ethylthio. Examples of "R⁴C₁₋₆alkylsulphinyl" include R⁴methylsulphinyl and 2-R⁴ethylsulphinyl. Examples of "R⁴C₁₋₆alkylsulphonyl" include R⁴mesyl and 2-R⁴ethylsulphonyl. Examples of R⁴C₂₋₆alkenyl are R⁴vinyl and R⁴allyl. Examples of "C₂₋₆alkynyl" are R⁴ethynyl and R⁴propyn-1-yl. Examples of "N-(R⁴C₁₋₆alkyl)carbamoyl" are N-(R⁴methyl)aminocarbonyl and N-(2-R⁴ethyl)aminocarbonyl. Examples of "N-(HetC₁₋₆alkyl)carbamoyl" are morpholinomethylaminocarbonyl and 2-(piperidinoethyl)aminocarbonyl.

Where optional substituents are chosen from "one or more" groups it is to be understood that this definition includes all substituents being chosen from one of the specified groups or the substituents being chosen from two or more of the specified groups. For example

where optional substituents are chosen from one or more halo, C₁₋₆alkoxy and C₁₋₆alkyl, examples of possible combinations of substituents include 1) a bromo group, 2) two chloro groups, 3) a methoxy, ethoxy and propoxy substituent, 4) a fluoro and a methoxy group, 5) a methoxy, a methyl and an ethyl group, and 6) a chloro, a methoxy and an ethyl group.

- 5 In one particular aspect the present invention provides a compound of formula (I) wherein Ar is (optionally substituted phenylC₁₋₆alkyl)₂CH-, optionally substituted phenyl, optionally substituted naphthyl or an optionally substituted heteroaryl ring, said optional substituents being chosen from one or more of halo, C₁₋₆alkoxy, C₁₋₆alkyl, nitro, C₁₋₆alkanoylamino, trifluoromethyl, hydroxy, trifluoromethoxy, cyano, C₁₋₆alkanoyl, C₁₋₆alkanoyloxy, amino, C₁₋₆alkylamino, N,N-(C₁₋₆alkyl)₂amino, carboxy, carbamoyl, N-(C₁₋₆alkyl)carbamoyl, N,N-(C₁₋₆alkyl)₂carbamoyl, C₁₋₆alkoxycarbonyl, mercapto, C₁₋₆alkylsulphanyl, C₁₋₆alkylsulphiny, C₁₋₆alkylsulphonyl, sulphamoyl, N-(C₁₋₆alkyl)sulphamoyl, N,N-(C₁₋₆alkyl)₂sulphamoyl, aminoC₁₋₆alkyl, N-(C₁₋₆alkyl)aminoC₁₋₆alkyl, N,N-(C₁₋₆alkyl)₂aminoC₁₋₆alkyl, R⁵S-, R⁵C(O)- and R⁵CH₂-
- 10 wherein R⁵ is phenyl which is optionally substituted by one or more groups chosen from C₁₋₆alkyl, halo, trifluoromethyl, hydroxy, trifluoromethoxy, cyano, C₁₋₆alkoxy, C₁₋₆alkanoyl, C₁₋₆alkanoyloxy, amino, C₁₋₆alkylamino, N,N-(C₁₋₆alkyl)₂amino, C₁₋₆alkanoylamino, nitro, carboxy, carbamoyl, N-(C₁₋₆alkyl)carbamoyl, N,N-(C₁₋₆alkyl)₂carbamoyl, C₁₋₆alkoxycarbonyl, mercapto, C₁₋₆alkylsulphanyl, C₁₋₆alkylsulphiny, C₁₋₆alkylsulphonyl, sulphamoyl,
- 15 20 N-(C₁₋₆alkyl)sulphamoyl and N,N-(C₁₋₆alkyl)₂sulphamoyl;
- R¹ is H or C₁₋₆alkyl;
- R² is H, C₁₋₆alkyl (optionally substituted with one or more hydroxy, C₁₋₆alkylsulphanyl, C₁₋₆alkylsulphiny, C₁₋₆alkylsulphonyl, R⁴, R⁴C₁₋₆alkylsulphanyl, R⁴C₁₋₆alkylsulphiny and R⁴C₁₋₆alkylsulphonyl), or R² is C₁₋₆alkoxy (optionally substituted with one or more
- 25 C₂₋₆alkenyl, C₂₋₆alkynyl, R⁴, R⁴C₂₋₆alkenyl, R⁴C₂₋₆alkynyl and Het), or R² is C₂₋₆alkenyl, C₂₋₆alkynyl, C₁₋₆alkoxycarbonyl, carbamoyl, N-(C₁₋₆alkyl)carbamoyl, N,N-(C₁₋₆alkyl)₂carbamoyl, trifluoromethoxy, R⁴-, R⁴S-, R⁴C₁₋₆alkylsulphanyl, N-(R⁴C₁₋₆alkyl)carbamoyl, N-(HetC₁₋₆alkyl)carbamoyl, C₁₋₆alkanoylamino, C₁₋₆alkylsulphanyl, C₁₋₆alkylsulphiny or C₁₋₆alkylsulphonyl wherein R⁴ is optionally substituted phenyl, or an
- 30 optionally substituted 5 or 6 membered heteroaryl ring said optional substituents on R⁴ being

- chosen from one or more of C₁₋₆alkyl, halo, trifluoromethyl, hydroxy, trifluoromethoxy, cyano, C₁₋₆alkoxy, C₁₋₆alkanoyl, C₁₋₆alkanoyloxy, amino, C₁₋₆alkylamino, N,N-(C₁₋₆alkyl)₂amino, C₁₋₆alkanoylamino, nitro, carboxy, carbamoyl, N-(C₁₋₆alkyl)carbamoyl, N,N-(C₁₋₆alkyl)₂carbamoyl, C₁₋₆alkoxycarbonyl, mercapto, C₁₋₆alkylsulphanyl,
- 5 C₁₋₆alkylsulphinyl, C₁₋₆alkylsulphonyl, sulphamoyl, N-(C₁₋₆alkyl)sulphamoyl and N,N-(C₁₋₆alkyl)₂sulphamoyl; and

R³ is H or C₁₋₆alkyl;

or a pharmaceutically acceptable salt thereof.

In a still further aspect the present invention provides a compound of formula (I)

- 10 wherein Ar is phenyl substituted with 1 to 3 chloro or methyl moieties, or naphthyl substituted with 1 bromo atom; R¹ is H or C₁₋₆alkyl; R² is H, C₁₋₆alkyl (optionally substituted with one or more hydroxy, C₁₋₆alkylsulphanyl, C₁₋₆alkylsulphinyl, C₁₋₆alkylsulphonyl, R⁴, R⁴C₁₋₆alkylsulphanyl, R⁴C₁₋₆alkylsulphinyl or R⁴C₁₋₆alkylsulphonyl), C₁₋₆alkoxy (optionally substituted with one or more halogen, C₂₋₆alkenyl, C₂₋₆alkynyl, R⁴, R⁴C₂₋₆alkenyl,
- 15 R⁴C₂₋₆alkynyl or Het), C₂₋₆alkenyl, C₂₋₆alkynyl, C₁₋₆alkoxycarbonyl, carbamoyl, N-(C₁₋₆alkyl)carbamoyl, N,N-(C₁₋₆alkyl)₂carbamoyl, R⁴-, R⁴S-, R⁴C₁₋₆alkylsulphanyl, N-(R⁴C₁₋₆alkyl)carbamoyl, N-(HetC₁₋₆alkyl)carbamoyl, C₁₋₆alkanoylamino, C₁₋₆alkylsulphanyl, C₁₋₆alkylsulphinyl or C₁₋₆alkylsulphonyl; R⁴ is optionally substituted phenyl, or an optionally substituted 5 or 6 membered heteroaryl ring, said optional substituents on R⁴ being chosen
- 20 from one or more of C₁₋₆alkyl, halo, trifluoromethyl, hydroxy, trifluoromethoxy, cyano, C₁₋₆alkoxy, C₁₋₆alkanoyl, C₁₋₆alkanoyloxy, amino, C₁₋₆alkylamino, (C₁₋₆alkyl)₂amino, C₁₋₆alkanoylamino, nitro, carboxy, carbamoyl, N-(C₁₋₆alkyl)carbamoyl, N,N-(C₁₋₆alkyl)₂carbamoyl, C₁₋₆alkoxycarbonyl, mercapto, C₁₋₆alkylsulphanyl, C₁₋₆alkylsulphinyl, C₁₋₆alkylsulphonyl, sulphamoyl, N-(C₁₋₆alkyl)sulphamoyl or N,N-(C₁₋₆alkyl)₂sulphamoyl,
- 25 wherein two such adjacent groups may join to form a 6-membered saturated, partially saturated or unsaturated ring; Het is a fully saturated monocyclic 5 - 8 membered heterocyclic ring, with up to 4 ring heteroatoms; and, R³ is H or C₁₋₆alkyl; or a pharmaceutically acceptable salt thereof; provided that when R¹, R² and R³ are all hydrogen then Ar is not 4-chlorophenyl.

Preferred values for Ar, R¹, R² and R³ are as follows:

Preferably Ar is optionally substituted phenyl or optionally substituted naphthyl said optional substituents being chosen from one or more of halo and C₁₋₆alkyl.

More preferably Ar is phenyl substituted with 1 to 3 chloro or methyl moieties, or naphthyl substituted with 1 bromo group.

- 5 Particularly Ar is phenyl substituted with 2 chloro groups or naphthyl substituted with 1 bromo group.

More particularly Ar is 2,6-dichlorophenyl or 1-bromo-naphth-2-yl.

Preferably R¹ is hydrogen.

Preferably R² is hydrogen, C₁₋₆alkoxy (optionally substituted with one or more

- 10 C₂₋₆alkynyl, R⁴, R⁴C₂₋₆alkenyl, R⁴C₂₋₆alkynyl or Het), C₁₋₆alkanoylamino, trifluoromethoxy, C₁₋₆alkylsulphanyl or R⁴ wherein R⁴ is optionally substituted phenyl or an optionally substituted 5 or 6 membered heteroaryl ring said optional substituents being chosen from one or more C₁₋₆alkyl groups. Het is as defined above (that is it is: a fully saturated monocyclic 5 - 8 membered heterocyclic ring, with up to 4 ring heteroatoms; for example pyrrolidinyl,
- 15 imidazolidinyl, pyrazolidinyl, piperidyl, piperazinyl or morpholinyl).

- For example R² is hydrogen, C₁₋₆alkoxy (optionally substituted with one or more halogen, C₂₋₆alkynyl, R⁴, R⁴C₂₋₆alkenyl, R⁴C₂₋₆alkynyl or Het), C₁₋₆alkanoylamino, C₁₋₆alkylsulphanyl or R⁴; R⁴ is optionally substituted phenyl or an optionally substituted 5 or 6 membered heteroaryl ring said optional substituents being chosen from one or more C₁₋₆alkyl groups, wherein two such adjacent groups may join to form a 6-membered saturated, partially saturated or unsaturated ring; Het is a fully saturated monocyclic 5 - 8 membered heterocyclic ring, with up to 4 ring heteroatoms. For example R⁴ is optionally substituted: phenyl, pyridyl, triazolyl, pyrazolyl, furyl or thienyl. For example Het is pyrrolidinyl, imidazolidinyl, pyrazolidinyl, piperidyl, piperazinyl or morpholinyl.

- 25 More preferably R² is hydrogen, methoxy, ethoxy, propoxy, 3-phenylprop-2-nyloxy, 3-phenylprop-2-enyloxy, 2-morpholinoethoxy, acetamido, trifluoromethoxy, methylthio, ethylthio, propylthio, 2-propynylmethoxy, optionally substituted pyrazolyl, optionally substituted triazolyl, optionally substituted furyl, optionally substituted thieryl where said optional substituents are chosen from 1 or 2 methyl groups.

In another aspect the present invention provides a compound of formula (I) wherein R² is hydrogen, methoxy, ethoxy, propoxy, 3-phenylprop-2-yloxy, 3-phenylprop-2-enyloxy, 2-morpholinoethoxy, acetamido, 2,2,2-trifluoroethoxy, methylthio, ethylthio, *iso*-propylthio, 2-propynloxy, pyridylmethoxy, optionally substituted pyrazolyl, optionally substituted 5 triazolyl, optionally substituted furyl, optionally substituted thienyl where said optional substituents are chosen from 1 or 2 methyl groups or said 5-membered ring is fused to a benzene ring (to form, for example, a benzotriazolyl bicyclic ring system).

Particularly R² is methoxy, ethoxy, *n*-propoxy, 2-morpholinoethoxy, 2-propynloxy and isopropylthio.

10 Preferably R³ is hydrogen.

According to another aspect of the present invention there is provided a compound of the formula (I) wherein:

Ar is optionally substituted phenyl or optionally substituted naphthyl said optional substituents being chosen from one or more of halo and C₁₋₆alkyl;

15 R¹ is hydrogen;

R² is hydrogen, C₁₋₆alkoxy (optionally substituted with C₂₋₆alkynyl, R⁴C₂₋₆alkenyl, R⁴C₂₋₆alkynyl or Het), C₁₋₆alkanoylamino, trifluoromethoxy, C₁₋₆alkylsulphanyl or R⁴ wherein R⁴ is optionally substituted phenyl or an optionally substituted 5 or 6 membered heteroaryl ring said optional substituents being chosen from one or more C₁₋₆alkyl groups; and

20 R³ is hydrogen;

or a pharmaceutically acceptable salt thereof. Het is as defined above (that is it is: a fully saturated monocyclic 5 - 8 membered heterocyclic ring, with up to 4 ring heteroatoms; for example pyrrolidinyl, imidazolidinyl, pyrazolidinyl, piperidyl, piperazinyl or morpholinyl).

A further preferred class of compounds is that of formula (I) wherein:

25 Ar is phenyl substituted with 2 chloro groups or naphthyl substituted with 1 bromo group;

R¹ is hydrogen;

R² is methoxy, ethoxy, *n*-propoxy, 2-morpholinoethoxy, 2-propynloxy or isopropylthio; and

30 R³ is hydrogen;

10

or a pharmaceutically acceptable salt thereof.

In a further aspect the present invention provides a compound of formula (I) wherein Ar is phenyl optionally substituted with halogen (such as chlorine) or C₁₋₄ alkyl (such as methyl), or naphthyl optionally substituted by halogen (such as bromo); R¹ and R³ are both 5 hydrogen; and R² is hydrogen, C₁₋₆ alkoxy (optionally substituted by halogen (such as fluorine), pyridinyl or morpholinyl), C₁₋₆ alkylthio, C₂₋₆ alkenyloxy (optionally substituted by phenyl), C₂₋₆ alkynyoxy (optionally substituted by phenyl), C₁₋₄ alkylcarbonylamino or 10 optionally substituted 5 membered heteroaryl (such as thieryl, furyl (itself optionally substituted by C₁₋₄ alkyl), pyrazolyl (itself optionally substituted by C₁₋₄ alkyl) or benzotriazolyl); or a pharmaceutically acceptable salt thereof.

Preferred compounds are those of Examples 1 - 26 or a pharmaceutically acceptable salt thereof.

In a further aspect the present invention provides a compound of formula (I) wherein Ar is phenyl disubstituted with halogen (such as chlorine), or naphthyl monosubstituted by 15 halogen (such as bromo); R¹ and R³ are both hydrogen; and R² is C₁₋₆ alkoxy (optionally substituted by morpholinyl), C₁₋₆ alkylthio or C₂₋₆ alkynyoxy; or a pharmaceutically acceptable salt. Thus, R² is, for example, methoxy, ethoxy, *n*-propoxy, *iso*-propylthio, 2-propynyoxy or 2-morpholinoethoxy.

Especially preferred compounds are those of Examples 1, 3, 5, 8, 10, 16 or 19 or a 20 pharmaceutically acceptable salt thereof.

Suitable pharmaceutically acceptable salts include acid addition salts such as the methanesulphonate, fumarate, hydrochloride, hydrobromide, citrate and maleate salts and salts formed with phosphoric and sulphuric acid. In another aspect suitable salts are base salts such as an alkali metal salt for example a sodium salt, an alkaline earth metal salt for example a 25 calcium or a magnesium salt, an organic amine salt for example a salt with triethylamine, morpholine, *N*-methylpiperidine, *N*-ethylpiperidine, procaine, dibenzylamine, *N,N*-dibenzylethylamine or an amino acid for example a lysine salt. There may be more than one cation or anion depending on the number of charged functions and the valency of the cations or anions. A preferred pharmaceutically acceptable salt is a sodium salt.

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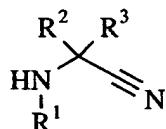
Some compounds of formula (I) may possess chiral centres. It is to be understood that the invention encompasses all such optical isomers and diastereoisomers of compounds of formula (I) which possess cysteine protease inhibitory activity.

The invention further relates to all tautomeric forms of the compounds of formula (I).

- 5 It is also to be understood that certain compounds of the formula (I) can exist in solvated as well as unsolvated forms such as, for example, hydrated forms. It is to be understood that the invention encompasses all such solvated forms.

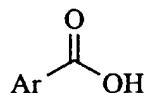
Another aspect of the present invention provides a process for preparing a compound of formula (I) or a pharmaceutically acceptable salt thereof. According to this aspect of the 10 invention there is provided a process (in which variable groups are as defined for formula (I) unless otherwise stated) which comprises:

- a) reacting an amine of formula (II)



(II)

15 with an acid of formula (III)



(III)

or a reactive derivative thereof.

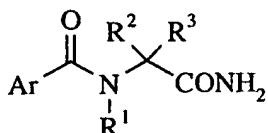
- 20 A suitable reactive derivative of an acid of the formula (II) is, for example, an acyl halide, for example an acyl chloride formed by the reaction of the acid and an inorganic acid chloride, for example thionyl chloride; a mixed anhydride, for example an anhydride formed by the reaction of the acid and a chloroformate such as isobutyl chloroformate; an active ester, for example an ester formed by the reaction of the acid and a phenol such as 25 pentafluorophenol, an ester such as pentafluorophenyl trifluoroacetate, an alcohol such as 1-hydroxybenzotriazole or a uronium salt such as 2-(1-benzotriazolyl)-1,1,3,3-

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tetramethyluronium hexafluorophosphate(V); an acyl azide, for example an azide formed by the reaction of the acid and an azide such as diphenylphosphoryl azide; an acyl cyanide, for example a cyanide formed by the reaction of an acid and a cyanide such as diethylphosphoryl cyanide; or the product of the reaction of the acid and a carbodiimide such as *N,N*-5 dicyclohexylcarbodiimide or 1-(3-dimethylaminopropyl)-3-ethylcarbodiimide.

The reaction is preferably carried out in the presence of a suitable base such as, for example, an alkali or alkaline earth metal carbonate, alkoxide or hydroxide, for example sodium carbonate or potassium carbonate, or, for example, an organic amine base such as, for example, pyridine, 2,6-lutidine, collidine, 4-dimethylaminopyridine, triethylamine, morpholine 10 or diazabicyclo-[5.4.0]undec-7-ene. The reaction is also preferably carried out in a suitable inert solvent or diluent, for example methylene chloride, acetonitrile, tetrahydrofuran, 1,2-dimethoxyethane, *N,N*-dimethylformamide, *N,N*-dimethylacetamide, *N*-methylpyrrolidin-2-one or dimethylsulphoxide, and at a temperature in the range, for example, -78° to 150°C, conveniently at or near ambient temperature.

15 b) dehydration of an amide of formula (IV)



(IV)

under standard conditions.

For example such a dehydration reaction may conventionally be carried out by reaction 20 with a reagent such as trifluoroacetic anhydride. The reaction can conveniently be conducted in the presence of a suitable base as defined hereinbefore such as, for example, triethylamine. The reaction is also preferably carried out in a suitable inert solvent or diluent, as defined hereinbefore such as dichloromethane and at a temperature in the range, for example, -10°C to reflux conveniently 10°C to reflux.

25 If not commercially available, the necessary starting materials for the procedures described above may be made by procedures which are selected from standard organic chemical techniques, techniques which are analogous to the synthesis of known, structurally

similar compounds, by techniques which are analogous to the above described procedures or by techniques which are analogous to the procedures described in the examples.

For example, it will be appreciated that certain of the optional substituents on a phenyl or naphthyl or a heteroaryl ring in the compounds of the present invention may be introduced

5 by standard aromatic substitution reactions or generated by conventional functional group modifications either prior to or immediately following the processes mentioned above, and as such are included in the process aspect of the invention. Such reactions and modifications include, for example, introduction of a substituent by means of an aromatic substitution reaction, reduction of substituents, alkylation of substituents and oxidation of substituents. The
10 reagents and reaction conditions for such procedures are well known in the chemical art.

Particular examples of aromatic substitution reactions include the introduction of a nitro group using concentrated nitric acid, the introduction of an acyl group using, for example, an acyl halide and a Lewis acid (such as aluminium trichloride) under Friedel Crafts conditions; the introduction of an alkyl group using an alkyl halide and Lewis acid (such as aluminium
15 trichloride) under Friedel Crafts conditions; and the introduction of a halogeno group.

Particular examples of modifications include the reduction of a nitro group to an amino group by for example, catalytic hydrogenation with a nickel catalyst or treatment with iron in the presence of hydrochloric acid with heating; oxidation of alkylthio to alkylsulphinyl or alkylsulphonyl.

20 It will also be appreciated that in some of the reactions mentioned herein it may be necessary/desirable to protect any sensitive groups in the compounds. The instances where protection is necessary or desirable and suitable methods for protection are known to those skilled in the art. Thus, if reactants include groups such as amino, carboxy or hydroxy it may be desirable to protect the group in some of the reactions mentioned herein.

25 A suitable protecting group for an amino or alkylamino group is, for example, an acyl group, for example an alkanoyl group such as acetyl, an alkoxy carbonyl group, for example a methoxycarbonyl, ethoxycarbonyl or *t*-butoxycarbonyl group, an arylmethoxycarbonyl group, for example benzylloxycarbonyl, or an aroyl group, for example benzoyl. The deprotection conditions for the above protecting groups necessarily vary with the choice of protecting
30 group. Thus, for example, an acyl group such as an alkanoyl or alkoxy carbonyl group or an

- aryloyl group may be removed for example, by hydrolysis with a suitable base such as an alkali metal hydroxide, for example lithium or sodium hydroxide. Alternatively an acyl group such as a *t*-butoxycarbonyl group may be removed, for example, by treatment with a suitable acid as hydrochloric, sulphuric or phosphoric acid or trifluoroacetic acid and an arylmethoxycarbonyl
- 5 group such as a benzyloxycarbonyl group may be removed, for example, by hydrogenation over a catalyst such as palladium-on-carbon, or by treatment with a Lewis acid for example boron tris(trifluoroacetate). A suitable alternative protecting group for a primary amino group is, for example, a phthaloyl group which may be removed by treatment with an alkylamine, for example dimethylaminopropylamine, or with hydrazine.
- 10 A suitable protecting group for a hydroxy group is, for example, an acyl group, for example an alkanoyl group such as acetyl, an aroyl group, for example benzoyl, or an arylmethyl group, for example benzyl. The deprotection conditions for the above protecting groups will necessarily vary with the choice of protecting group. Thus, for example, an acyl group such as an alkanoyl or an aroyl group may be removed, for example, by hydrolysis with
- 15 a suitable base such as an alkali metal hydroxide, for example lithium or sodium hydroxide. Alternatively an arylmethyl group such as a benzyl group may be removed, for example, by hydrogenation over a catalyst such as palladium-on-carbon.
- A suitable protecting group for a carboxy group is, for example, an esterifying group, for example a methyl or an ethyl group which may be removed, for example, by hydrolysis
- 20 with a base such as sodium hydroxide, or for example a *t*-butyl group which may be removed, for example, by treatment with an acid, for example an organic acid such as trifluoroacetic acid, or for example a benzyl group which may be removed, for example, by hydrogenation over a catalyst such as palladium-on-carbon.
- The protecting groups may be removed at any convenient stage in the synthesis using
- 25 conventional techniques well known in the chemical art.
- Many of the intermediates defined herein are novel, for example, those of the formula (IV) and these are provided as a further feature of the invention.
- According to a further feature of the invention there is provided a compound of the formula (I), or a pharmaceutically acceptable salt thereof, for use in a method of treatment of
- 30 the human or animal body by therapy.

According to a further feature of the present invention there is provided a method for producing inhibition of a cysteine protease in a warm blooded animal, such as man, in need of such treatment, which comprises administering to said animal an effective amount of a compound of the present invention, or a pharmaceutically acceptable salt thereof.

- 5 The invention also provides a compound of the formula wherein Ar is (optionally substituted phenylC₁₋₆alkyl)₂CH-, substituted phenyl (but not phenyl substituted only with nitro) or optionally substituted naphthyl, said optional substituents being chosen from one or more of halo, C₁₋₆alkoxy, C₁₋₆alkyl, nitro, C₁₋₆alkanoylamino, trifluoromethyl, hydroxy, trifluoromethoxy, cyano, C₁₋₆alkanoyl, C₁₋₆alkanoyloxy, amino, C₁₋₆alkylamino,
- 10 (C₁₋₆alkyl)₂amino, carboxy, carbamoyl, N-(C₁₋₆alkyl)carbamoyl, N,N-(C₁₋₆alkyl)₂carbamoyl, C₁₋₆alkoxycarbonyl, mercapto, C₁₋₆alkylsulphanyl, C₁₋₆alkylsulphinyl, C₁₋₆alkylsulphonyl, sulphamoyl, N-(C₁₋₆alkyl)sulphamoyl, N,N-(C₁₋₆alkyl)₂sulphamoyl, aminoC₁₋₆alkyl, N-(C₁₋₆alkyl)aminoC₁₋₆alkyl, (C₁₋₆alkyl)₂aminoC₁₋₆alkyl, R⁵S-, R⁵C(O)- or R⁵CH₂-; R⁵ is phenyl which is optionally substituted by one or more groups chosen from C₁₋₆alkyl, halo,
- 15 trifluoromethyl, hydroxy, trifluoromethoxy, cyano, C₁₋₆alkoxy, C₁₋₆alkanoyl, C₁₋₆alkanoyloxy, amino, C₁₋₆alkylamino, (C₁₋₆alkyl)₂amino, C₁₋₆alkanoylamino, nitro, carboxy, carbamoyl, N-(C₁₋₆alkyl)carbamoyl, N,N-(C₁₋₆alkyl)₂carbamoyl, C₁₋₆alkoxycarbonyl, mercapto, C₁₋₆alkylsulphanyl, C₁₋₆alkylsulphinyl, C₁₋₆alkylsulphonyl, sulphamoyl, N-(C₁₋₆alkyl)sulphamoyl or N,N-(C₁₋₆alkyl)₂sulphamoyl; R¹ is H or C₁₋₆alkyl; R² is H,
- 20 C₁₋₆alkyl (optionally substituted with one or more hydroxy, C₁₋₆alkylsulphanyl, C₁₋₆alkylsulphinyl, C₁₋₆alkylsulphonyl, R⁴, R⁴C₁₋₆alkylsulphanyl, R⁴C₁₋₆alkylsulphinyl or R⁴C₁₋₆alkylsulphonyl), C₁₋₆alkoxy (optionally substituted with one or more halogen, C₂₋₆alkenyl, C₂₋₆alkynyl, R⁴, R⁴C₂₋₆alkenyl, R⁴C₂₋₆alkynyl or Het), C₂₋₆alkenyl, C₂₋₆alkynyl, C₁₋₆alkoxycarbonyl, carbamoyl, N-(C₁₋₆alkyl)carbamoyl, N,N-(C₁₋₆alkyl)₂carbamoyl, R⁴-,
- 25 R⁴S-, R⁴C₁₋₆alkylsulphanyl, N-(R⁴C₁₋₆alkyl)carbamoyl, N-(HetC₁₋₆alkyl)carbamoyl, C₁₋₆alkanoylamino, C₁₋₆alkylsulphanyl, C₁₋₆alkylsulphinyl or C₁₋₆alkylsulphonyl; R⁴ is optionally substituted phenyl, or an optionally substituted 5 or 6 membered heteroaryl ring, said optional substituents on R⁴ being chosen from one or more of C₁₋₆alkyl, halo, trifluoromethyl, hydroxy, trifluoromethoxy, cyano, C₁₋₆alkoxy, C₁₋₆alkanoyl, C₁₋₆alkanoyloxy,
- 30 amino, C₁₋₆alkylamino, (C₁₋₆alkyl)₂amino, C₁₋₆alkanoylamino, nitro, carboxy, carbamoyl,

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N-(C₁₋₆alkyl)carbamoyl, *N,N*-(C₁₋₆alkyl)₂carbamoyl, C₁₋₆alkoxycarbonyl, mercapto, C₁₋₆alkylsulphanyl, C₁₋₆alkylsulphinyl, C₁₋₆alkylsulphonyl, sulphamoyl, *N*-(C₁₋₆alkyl)sulphamoyl or *N,N*-(C₁₋₆alkyl)₂sulphamoyl, wherein two such adjacent groups may join to form a 6-membered saturated, partially saturated or unsaturated ring; Het is a fully 5 saturated monocyclic 5 - 8 membered heterocyclic ring, with up to 4 ring heteroatoms; and, R³ is H or C₁₋₆alkyl; or a pharmaceutically acceptable salt thereof; for use as a medicament.

- In another aspect the present invention provides the use of a compound of the formula (I), wherein Ar is (optionally substituted phenyl)C₁₋₆alkyl)₂CH-, optionally substituted phenyl, optionally substituted naphthyl or an optionally substituted heteroaryl ring, said optional 10 substituents being chosen from one or more of halo, C₁₋₆alkoxy, C₁₋₆alkyl, nitro, C₁₋₆alkanoylamino, trifluoromethyl, hydroxy, trifluoromethoxy, cyano, C₁₋₆alkanoyl, C₁₋₆alkanoyloxy, amino, C₁₋₆alkylamino, (C₁₋₆alkyl)₂amino, carboxy, carbamoyl, *N*-(C₁₋₆alkyl)carbamoyl, *N,N*-(C₁₋₆alkyl)₂carbamoyl, C₁₋₆alkoxycarbonyl, mercapto, C₁₋₆alkylsulphanyl, C₁₋₆alkylsulphinyl, C₁₋₆alkylsulphonyl, sulphamoyl, 15 *N*-(C₁₋₆alkyl)sulphamoyl, *N,N*-(C₁₋₆alkyl)₂sulphamoyl, aminoC₁₋₆alkyl, *N*-(C₁₋₆alkyl)aminoC₁₋₆alkyl, (C₁₋₆alkyl)₂aminoC₁₋₆alkyl, R⁵S-, R⁵C(O)- or R⁵CH₂-; R⁵ is phenyl which is optionally substituted by one or more groups chosen from C₁₋₆alkyl, halo, trifluoromethyl, hydroxy, trifluoromethoxy, cyano, C₁₋₆alkoxy, C₁₋₆alkanoyl, C₁₋₆alkanoyloxy, amino, C₁₋₆alkylamino, (C₁₋₆alkyl)₂amino, C₁₋₆alkanoylamino, nitro, carboxy, carbamoyl, 20 *N*-(C₁₋₆alkyl)carbamoyl, *N,N*-(C₁₋₆alkyl)₂carbamoyl, C₁₋₆alkoxycarbonyl, mercapto, C₁₋₆alkylsulphanyl, C₁₋₆alkylsulphinyl, C₁₋₆alkylsulphonyl, sulphamoyl, *N*-(C₁₋₆alkyl)sulphamoyl or *N,N*-(C₁₋₆alkyl)₂sulphamoyl; R¹ is H or C₁₋₆alkyl; R² is H, C₁₋₆alkyl (optionally substituted with one or more hydroxy, C₁₋₆alkylsulphanyl, C₁₋₆alkylsulphinyl, C₁₋₆alkylsulphonyl, R⁴, R⁴C₁₋₆alkylsulphanyl, R⁴C₁₋₆alkylsulphinyl or 25 R⁴C₁₋₆alkylsulphonyl), C₁₋₆alkoxy (optionally substituted with one or more halogen, C₂₋₆alkenyl, C₂₋₆alkynyl, R⁴, R⁴C₂₋₆alkenyl, R⁴C₂₋₆alkynyl or Het), C₂₋₆alkenyl, C₂₋₆alkynyl, C₁₋₆alkoxycarbonyl, carbamoyl, *N*-(C₁₋₆alkyl)carbamoyl, *N,N*-(C₁₋₆alkyl)₂carbamoyl, R⁴-, R⁴S-, R⁴C₁₋₆alkylsulphanyl, *N*-(R⁴C₁₋₆alkyl)carbamoyl, *N*-(HetC₁₋₆alkyl)carbamoyl, C₁₋₆alkanoylamino, C₁₋₆alkylsulphanyl, C₁₋₆alkylsulphinyl or C₁₋₆alkylsulphonyl; R⁴ is 30 optionally substituted phenyl, or an optionally substituted 5 or 6 membered heteroaryl ring,

said optional substituents on R⁴ being chosen from one or more of C₁₋₆alkyl, halo, trifluoromethyl, hydroxy, trifluoromethoxy, cyano, C₁₋₆alkoxy, C₁₋₆alkanoyl, C₁₋₆alkanoyloxy, amino, C₁₋₆alkylamino, (C₁₋₆alkyl)₂amino, C₁₋₆alkanoylamino, nitro, carboxy, carbamoyl, N-(C₁₋₆alkyl)carbamoyl, N,N-(C₁₋₆alkyl)₂carbamoyl, C₁₋₆alkoxycarbonyl, mercapto,

5 C₁₋₆alkylsulphonyl, C₁₋₆alkylsulphanyl, C₁₋₆alkylsulphinyl, sulphamoyl, N-(C₁₋₆alkyl)sulphamoyl or N,N-(C₁₋₆alkyl)₂sulphamoyl, wherein two such adjacent groups may join to form a 6-membered saturated, partially saturated or unsaturated ring; Het is a fully saturated monocyclic 5 - 8 membered heterocyclic ring, with up to 4 ring heteroatoms; and, R³ is H or C₁₋₆alkyl; or a pharmaceutically acceptable salt thereof; in the manufacture of a

10 medicament for use in the inhibition of a cysteine protease in a warm blooded animal, such as man.

The invention further provides the use of a compound of formula (I), or a pharmaceutically acceptable salt thereof, in the manufacture of a medicament for use in the treatment of chronic obstructive pulmonary disease (COPD) in a warm blooded animal, such as man.

15

In particular the invention provides the use of a compound of the formula (I) of the present invention, or a pharmaceutically acceptable salt thereof, in the manufacture of a medicament for use in the inhibition of Cathepsin S in a warm blooded animal, such as man.

The invention also provides the use of a compound of the formula (I) of the present invention, or a pharmaceutically acceptable salt thereof, in the manufacture of a medicament for use in the inhibition of Cathepsin L in a warm blooded animal, such as man.

The present invention further provides a method of treating a Cathepsin L or Cathepsin S mediated disease state in mammals which comprises administering to a mammal in need of such treatment an effective amount of a compound of formula (I), or a pharmaceutically acceptable salt thereof.

In order to use a compound of the formula (I) or a pharmaceutically acceptable salt thereof for the therapeutic treatment of mammals including humans, in particular in the inhibition of a cysteine protease, it is normally formulated in accordance with standard pharmaceutical practice as a pharmaceutical composition.

Therefore in another aspect the present invention provides a pharmaceutical composition which comprises a compound of the formula (I) or a pharmaceutically acceptable salt thereof and a pharmaceutically acceptable diluent or carrier.

- The pharmaceutical compositions of this invention may be administered in standard manner for the disease condition that it is desired to treat, for example by oral, rectal or parenteral administration. For these purposes the compounds of this invention may be formulated by means known in the art into the form of, for example, tablets, capsules, aqueous or oily solutions or suspensions, (lipid) emulsions, dispersible powders, suppositories, ointments, creams, drops and sterile injectable aqueous or oily solutions or suspensions.
- 10 A suitable pharmaceutical composition of this invention is one suitable for oral administration in unit dosage form, for example a tablet or capsule which contains between 100 mg and 1 g of the compound of this invention.

In another aspect a pharmaceutical composition of the invention is one suitable for intravenous, subcutaneous or intramuscular injection.

- 15 Each patient may receive, for example, an intravenous, subcutaneous or intramuscular dose of 1 mg kg^{-1} to 100 mg kg^{-1} of the compound, preferably in the range of 5 mg kg^{-1} to 20 mg kg^{-1} of this invention, the composition being administered 1 to 4 times per day. The intravenous, subcutaneous and intramuscular dose may be given by means of a bolus injection. Alternatively the intravenous dose may be given by continuous infusion over a period of time.
- 20 Alternatively each patient will receive a daily oral dose which is approximately equivalent to the daily parenteral dose, the composition being administered 1 to 4 times per day.

The following illustrate representative pharmaceutical dosage forms containing the compound of formula (I), or a pharmaceutically-acceptable salt thereof (hereafter compound X), for therapeutic or prophylactic use in humans:

(a)

<u>Tablet I</u>	<u>mg/tablet</u>
Compound X.	100
Lactose Ph.Eur.	179
Croscarmellose sodium	12.0
Polyvinylpyrrolidone	6
Magnesium stearate	3.0

(b)

<u>Tablet II</u>	<u>mg/tablet</u>
Compound X	50
Lactose Ph.Eur.	229
Croscarmellose sodium	12.0
Polyvinylpyrrolidone	6
Magnesium stearate	3.0

5 (c)

<u>Tablet III</u>	<u>mg/tablet</u>
Compound X	1.0
Lactose Ph.Eur.	92
Croscarmellose sodium	4.0
Polyvinylpyrrolidone	2.0
Magnesium stearate	1.0

(d)

<u>Capsule</u>	<u>mg/capsule</u>
Compound X	10
Lactose Ph.Eur.	389
Croscarmellose sodium	100
Magnesium stearate	1.

(e)

<u>Injection I</u>	<u>(50 mg/ml)</u>
Compound X	5.0% w/v
Isotonic aqueous solution	to 100%

5 Buffers, pharmaceutically-acceptable cosolvents such as polyethylene glycol, polypropylene glycol, glycerol or ethanol or complexing agents such as hydroxy-propyl β cyclodextrin may be used to aid formulation.

Note

The above formulations may be obtained by conventional procedures well known in the
10 pharmaceutical art. The tablets (a)-(c) may be enteric coated by conventional means, for example to provide a coating of cellulose acetate phthalate.

Inhibition of Cathepsin L and S.

The pharmaceutically-acceptable compounds of the present invention are useful in the
15 inhibition of Cathepsin L and Cathepsin S, having a good activity *in vitro* against human Cathepsin L, human Cathepsin S and rabbit Cathepsin L.

Cathepsin L Assay

Recombinant human Cathepsin L was cloned and expressed in E Coli and purified
20 using the method as described by Zeneca Limited, GB 2 306 961 A (published 14.05.1997).

Rabbit Cathepsin L was purified from rabbit liver as described by Maciewicz R. A. and Etherington D. J. (Biochem. J. (1988) 256, 433-440) except the liver homogenate supernatant

was concentrated by fractionation with $(\text{NH}_4)_2\text{SO}_4$ (20-80% saturation), and the pellet taken up and dialysed against 20mM NaAcetate pH 5.5, 1mM ethylenediaminetetraacetic acid (EDTA). The supernatant was then applied to a CM Sepharose ion exchange column and Cathepsin L eluted by gradient elution (0.25-0.75M NaCl). Fraction activity was determined using the 5 synthetic substrate NCBz-Phe-Arg-NHMec as described. Cathepsin L fractions were pooled and desalting on a Sephadryl S100 column. Active fractions were pooled, adjusted to 20% saturation $(\text{NH}_4)_2\text{SO}_4$ and concentrated on a phenyl sepharose column. The remaining purification steps were as described.

Cathepsin L activity was measured based on the method of Barrett and Kirschke (1981 10 Methods in Enzymology, 80, 535-561), using the fluorogenic substrates NCBz-Phe-Arg- NHMec. Inhibitors were identified by their ability to decrease the generation of the fluorescent leaving group (NHMec). Briefly the assay was as follows:

rHuman Cathepsin L or rabbit Cathepsin L (0.025 pmoles) was pre-incubated with or without test compound in 0.1M sodium acetate buffer pH4.5, 10mM cysteine, 0.1% Brij 35 at 15 25°C for 15 minutes in a solid black 96 well plate. Synthetic substrate, 20 μ M NCBz-Phe-Arg- NHMec, was added and the mixture incubated at 37°C for 30 minutes. The reaction was stopped by the addition of 0.1M sodium chloroacetate pH 4.3. Fluorescence was determined using a Fluoroskan II plate reader; excitation 355nm, emission 460nm. Compound potency was determined from the raw fluorescence data by calculating the IC₅₀ against each enzyme 20 using a PC graph drawing software package.

Cathepsin S assay.

Cloning and Expression of human Cathepsin S.

Recombinant human Cathepsin S was cloned and expressed in Baculovirus, by the following method. The cDNA sequence for human Cathepsin S is available in the EMBL 25 database Accession Number M90696. This database sequence was used to prepare, by PCR on mRNA from human tissues, a recombinant plasmid carrying an insert with a DNA sequence identical to that of Cathepsin S in the EMBL database (Acc No M90696). The techniques for mRNA isolation, PCR and cloning are standard techniques known by those skilled in the art. Sequence determination of the recombinant insert was carried out using established DNA 30 sequencing techniques.

The PCR was done so as to introduce an EcoRI cloning site 5' of the 'ATG' of Cathepsin S and an XbaI cloning site 3' of the 'Stop' codon. The PCR product was cloned between the EcoRI and XbaI sites of the baculovirus transfer vector pFASTBAC-1 (Bac-to-Bac Expression System commercially available from Gibco BRL -Life Technologies (cat no 5 10359-016)). This recombinant construct was used to generate, by standard techniques, a recombinant baculovirus capable of expressing procathepsin S.

Expression of recombinant Cathepsin S was tested for the baculoviral constructs by infection of two insect cell lines : Sf9 cells (ATCC No CRL-1711) and T.ni cells (Invitrogen, Cat No B855-02).

10 Purification of Cathepsin S

Method 1.

Procathepsin S was found in the insect cell medium and acid activated. The medium was mixed with an equal volume of 100mM Sodium Acetate buffer pH 4.5, 5mM dithiothreitol (DTT) and 5mM EDTA and incubated for one hour at 37°C method of Maubach 15 et al (Eur. J. Biochem., 250, 745-750, 1997).

Method 2.

The pH of insect cell medium (10ml) containing procathepsin S was adjusted to 4.5 with glacial acetic acid and DTT and EDTA added to 5mM. The sample was then incubated at 20 37°C for 150min to enable conversion to the active enzyme. Ammonium sulphate was then added to 80% saturation and a pellet obtained by centrifugation. This pellet was redissolved in 2ml buffer A (100mM Tris, 500mM NaCl, 1mM EDTA, pH7.5) and mixed in a batchwise fashion with 100µl thiopropyl-Sepharose for 15min at 4°C. The non bound fraction was removed by a brief centrifugation and the gel washed with 2x1ml buffer A. Cathepsin S was 25 then eluted by batch mixing with 0.4ml 20mM DTT in buffer A for 15min at 4°C.

Measurement of Cathepsin S Activity.

Cathepsin S activity was measured based on the method of Maubach et al (Eur. J. Biochem., 250, 745-750, 1997), using the fluorogenic substrate Z-Val-Val-Arg-NHMec.

Inhibitors were identified by their ability to decrease the generation of the fluorescent leaving group (NHMec). Briefly the assay was as follows:

rHuman Cathepsin S (1.5 nmoles) was pre-incubated with or without compounds in 50mM Potassium phosphate buffer pH 6.0-6.2, 20mM Na₂EDTA, 0.1% Brij at 25°C for 5 minutes in a solid black 96 well plate. Synthetic substrate, 20μM Z-Val-Val-Arg-NHMec, was added and the mixture incubated at 30°C for 20 minutes. The reaction was stopped by the addition of 0.1M sodium chloroacetate pH 4.3. Fluorescence was determined using a Fluoroskan II plate reader; excitation 355nm, emission 460nm. Compound potency was determined from the raw fluorescence data by calculating the IC₅₀ against Cathepsin S using a PC graph drawing software package.

The following results were obtained on a standard *in-vitro* test system for the inhibition of Cathepsin L. The activity is described in terms of IC₅₀.

When tested in the above *in-vitro* tests the compounds of this invention give IC_{50s} in the range 1-10,000 nM.

15 The following data was obtained for Examples 5, 14 and 23.

Example	IC ₅₀ (Human)	IC ₅₀ (Rabbit)
5	1000	90
14	3113	-
23	38	38.27

Examples

The invention will now be illustrated by the following non-limiting examples in which,

20 unless stated otherwise:

- (i) temperatures are given in degrees Celsius (°C); operations were carried out at room or ambient temperature, that is, at a temperature in the range of 18-25°C;
- (ii) organic solutions were dried over anhydrous magnesium sulphate; evaporation of solvent was carried out using a rotary evaporator under reduced pressure (600-4000 Pascals; 4.5-30 mm Hg) with a bath temperature of up to 60°C;
- (iii) chromatography means flash chromatography on silica gel; thin layer chromatography

- (TLC) was carried out on silica gel plates;
- (iv) in general, the course of reactions was followed by TLC and reaction times are given for illustration only;
- (v) final products had satisfactory proton nuclear magnetic resonance (NMR) spectra;
- 5 (vi) yields are given for illustration only and are not necessarily those which can be obtained by diligent process development; preparations were repeated if more material was required;
- (vii) when given, NMR data is in the form of delta values for major diagnostic protons, given in parts per million (ppm) relative to tetramethylsilane (TMS) as an internal standard, determined at 250 MHz using perdeuterio dimethyl sulphoxide ($\text{DMSO}-\delta_6$) as the solvent
- 10 unless otherwise stated;
- (viii) chemical symbols have their usual meanings; SI units and symbols are used;
- (ix) solvent ratios are given in percentage by volume;
- (x) mass spectra (MS) were run with an electron energy of 70 electron volts in the chemical ionisation (CI) mode using a direct exposure probe; where indicated ionisation was effected by
- 15 electron impact (EI) or fast atom bombardment (FAB); where values for m/z are given, generally only ions which indicate the parent mass are reported; and
- (xi) melting points are uncorrected and (dec) indicates decomposition; the melting points given are those obtained for the materials prepared as described; polymorphism may result in isolation of materials with different melting points in some preparations.

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Example 1**2-(2,6-Dichlorobenzamido)-2-propoxyacetonitrile**

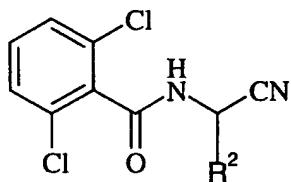
Trifluoroacetic anhydride (0.51 ml) was added dropwise to a stirred mixture of 2-(2,6-dichlorobenzamido)-2-propoxyacetamide (360 mg) in pyridine (5 ml) at -10°C. The mixture
25 was allowed to warm to ambient temperature then poured into ice-water and extracted with ether. The organic phase was washed with brine, dried and evaporated to dryness under reduced pressure. The residue was triturated with hexane and the insoluble solid collected to give 2-(2,6-dichlorobenzamido)-2-propoxyacetonitrile (235 mg). Mp 115-117°C; m/z 287 (MH^+); NMR 0.9 (t, 3H), 1.55 (m, 2H), 3.6 (t, 2H), 6.25 (d, 1H), 7.4-7.6 (m, 3H), 10.35 (d,
30 1H).

Example 22-(2,6-Dichlorobenzamido)-2-(3,5-dimethylpyrazol-1-yl)acetonitrile

POCl₃ (0.34 ml) was added dropwise to stirred ice cooled *N,N*-dimethylformamide (3 ml) and the mixture was added dropwise to a stirred solution of 2-(2,6-dichlorobenzamido)-2-(3,5-dimethylpyrazol-1-yl)acetamide (500 mg) in *N,N*-dimethylformamide (4 ml). The solution was stirred at ambient temperature for 0.5 hours then poured into water. The mixture was extracted with ethyl acetate and the extract was dried and evaporated to dryness. The residue was triturated with ether and the insoluble solid collected to give 2-(2,6-dichlorobenzamido)-2-(3,5-dimethylpyrazol-1-yl)acetonitrile (214 mg). m/z 323 (MH⁺); NMR 2.15 (s, 3H), 2.35 (s, 3H), 5.95 (s, 1H), 7.4-7.55 (m, 4H), 10.7 (d, 1H).

Examples 3-15

The compounds listed in the following table were made by processes analogous to either Example 1 or Example 2.



Example	R ²	mp (°C)	MH ⁺	Example
3	ethoxy	151-152	273	1
4	pyrazol-1-yl	202-203	294 (M ⁺)	1
5	methoxy	148-150	259	1
6	PhC≡CCH ₂ O-	165-167	359	1
7	PhCH=CHCH ₂ O-	137-139	361	1
8	2-Morpholinoethoxy	-	358	1
9	ethylthio	129-130	289	2
10	2-propynyoxy	82-87	283	1
11	methylthio	-	275	2
12	(2-pyridyl)methoxy	-	336	2
13	2,2,2-trifluoroethoxy	-	349 (MNa ⁺)	1

14	acetamido	-	286	2
15	benzotriazol-1-yl	-	346	2

Ph = phenyl

Example 16

2-(1-Bromo-2-naphthoylamino)-2-isopropylthioacetonitrile

The process described in Example 2 was repeated using 2-(1-bromo-2-

- 5 naphthoylamino)-2-isopropylthioacetamide as starting material to give 2-(1-bromo-2-naphthoylamino)-2-isopropylthioacetonitrile. Mp 121-122°C; m/z 363 (MH^+) NMR (CDCl_3) 1.4 (d, 3H), 1.5 (d, 3H), 3.4 (m, 1H), 6.25 (d, 1H), 6.8 (m, 1H), 7.4 (d, 1H), 7.65 (m, 2H), 7.85 (m, 2H), 8.35 (d, 1H).

Example 17

10 **2-(2,4-Dichlorobenzamido)-2-isopropylthioacetonitrile**

The process described in Example 2 was repeated using 2-(2,4-dichlorobenzamido)-2-isopropylthioacetamide as starting material to give 2-(2,4-dichlorobenzamido)-2-isopropylthioacetonitrile. Mp 110-111°C; m/z 303 (MH^+) NMR (CDCl_3); 1.35 (d, 3H), 1.45 (d, 3H), 3.35 (m, 1H), 6.15 (d, 1H), 7.1 (m, 1H), 7.35 (dd, 1H), 7.45 (d, 1H), 7.7 (d, 1H).

15 **Example 18**

2-(2,6-Dichlorobenzamido)-2-isopropylthioacetonitrile

A solution of 2-benzyloxycarbonylamino-2-isopropylthioacetonitrile (450 mg) in dichloromethane (10 ml) was stirred under argon and then treated with iodotrimethylsilane (0.28 ml). The solution was stirred for 0.5 hours then treated with methanol (0.2 ml) and the 20 mixture was evaporated to dryness under reduced pressure. A solution of the residue in dichloromethane (10 ml) was stirred under argon and treated with 2,6-dichlorobenzoyl chloride (420 mg) followed by triethylamine (0.5 ml) and the mixture was stirred at ambient temperature for 18 hours. The mixture was evaporated to dryness under reduced pressure and a solution of the residue in diethyl ether was washed successively with 1M hydrochloric acid, 25 1M sodium hydroxide and brine, dried and evaporated to dryness under reduced pressure. The residue was purified by flash chromatography using increasingly polar mixtures of dichloromethane and hexane as eluent followed by recrystallisation from carbon tetrachloride

to give 2-(2,6-dichlorobenzamido)-2-isopropylthioacetonitrile (67 mg). M/z 303 (MH^+); NMR (CDCl_3) 1.35 (d, 3H), 1.45 (d, 3H), 3.35 (m, 1H), 6.15 (d, 1H), 6.4 (m, 1H), 7.3-7.4 (m, 3H).

Example 19

2-(1-Bromo-2-naphthoylamino)-2-methoxyacetonitrile

5 *N*-bromosuccinimide (70 mg) was added to a stirred solution of 2-(1-bromo-2-naphthoylamino)-2-isopropylthioacetonitrile (120 mg) in methanol (2 ml) at -30°C. The solution was allowed to warm to ambient temperature. It was stirred for 2 hours then treated with water and the mixture was extracted with ethyl acetate. The mixture was washed with brine, dried and evaporated to dryness under reduced pressure and the residue recrystallised
10 from a mixture of diethyl ether and hexane to give 2-(1-bromo-2-naphthoylamino)-2-methoxyacetonitrile (75 mg). Mp 162-164°C; m/z 319 (MH^+); NMR (CDCl_3) 3.65 (s, 3H), 6.2 (d, 1H), 6.95 (m, 1H), 7.5 (d, 1H), 7.65 (m, 2H), 7.9 (m, 2H), 8.4 (m, 1H).

Example 20

2-(2,4-Dichlorobenzamido)-2-methoxyacetonitrile

15 The process described in Example 19 was repeated using 2-(2,4-dichlorobenzamido)-2-isopropylthioacetonitrile as starting material to give 2-(2,4-dichlorobenzamido)-2-methoxyacetonitrile. Mp 105-106°C; m/z 259 (MH^+); NMR (CDCl_3) 3.55 (s, 3H), 6.15 (d, 1H), 7.2 (m, 1H), 7.4 (dd, 1H), 7.5 (d, 1H), 7.7 (d, 1H).

Example 21

2-(1-Bromo-2-naphthoylamino)acetonitrile

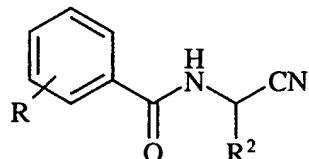
N,N-Dimethylformamide (0.05 ml) was added to a stirred mixture of 1-bromo-2-naphthoic acid (2 g), dichloromethane (20 ml) and oxalyl chloride (0.9 ml) and the mixture was stirred for 1 hour then evaporated to dryness under reduced pressure.

 A portion of the acid chloride (270 mg) was added to a stirred, ice cooled mixture of
25 aminoacetonitrile hydrochloride (0.14 g), dichloromethane (20 ml) and triethylamine (0.5 ml). The mixture was stirred at ambient temperature for 18 hours. Water was added and the dichloromethane separated and washed successively with 1M hydrochloric acid, 1M sodium hydroxide and brine, dried and evaporated to dryness under reduced pressure. The residue was recrystallised from a mixture of ethyl acetate and hexane to give 2-(1-bromo-2-

naphthoylamino)acetonitrile. Mp 172-173°C; m/z 289 (MH^+); NMR ($CDCl_3$) 4.45 (d, 2H), 6.65 (m, 1H), 7.5 (d, 1H), 7.65 (m, 2H), 7.85 (m, 2H), 8.35 (m, 1H).

Example 22 - 25

The following analogues were prepared according to the method of Example 21 using
5 the appropriate benzoic acids and substituted aminoacetonitriles:



Example	R	R^2	Mp °C
22	2,4-diCl	2-furyl	169-170
23	2,4,6-triMe		115.5-118
24	2-Cl		72.5-74
25	2,6-diCl	2-furyl	131-132

Example 26

2-(1-Bromo-2-naphthoylamino)-2-(2-thienyl)acetonitrile

10 The process described in Example 21 was repeated using 2-(2-thienyl)-2-aminoacetonitrile instead of aminoacetonitrile to give 2-(1-bromo-2-naphthoylamino)-2-(2-thienyl)acetonitrile. Mp 162-163°C; m/z 371 (M^+); NMR ($CDCl_3$); 6.55 (d, 2H), 6.7 (m, 1H), 7.1 (m, 1H), 7.4 (m, 2H), 7.5 (d, 1H), 7.65 (m, 2H), 7.85 (m, 2H), 8.35 (m, 1H).

15 Preparation of Starting Materials

The starting materials for the Examples above are either commercially available or are readily prepared by standard methods from known materials. For example the following reactions (Methods A-F) are illustrations but not limitations of the preparation of some of the starting materials used in the above reactions.

Method A**2-(2-Furyl)aminoacetonitrile**

Ammonium chloride (25 g) was added to a solution of 2-furfuraldehyde (25 g) in diethyl ether (250 ml). A solution of sodium cyanide (17 g) in water (80 ml) was added over 5 20 minutes. The reaction mixture was stirred at ambient temperature for 14 hours , the aqueous layer was removed and the organic layer was washed twice with saturated aqueous sodium hydrogen carbonate solution (100 ml each time), dried and evaporated to dryness. The residue was dissolved in diethyl ether (250 ml) and cooled to 0 °C. Hydrogen chloride gas was bubbled through the solution keeping the temperature below 10 °C. 2-(2-
10 Furyl)aminoacetonitrile hydrochloride was filtered and dried, yield 33 g. ¹H NMR 6.19 (s, 1H), 6.56 (m, 1H), 6.78 (d, 1H), 7.83 (m, 1H), 9.83 (broad s, 2H).

Methods A1-3

Following the method outlined in Method A and using the appropriate aldehyde there was prepared:

- 15 **A1** 2-[2-(5-methylfuryl)]aminoacetonitrile hydrochloride;
A2 2-(3-furyl)aminoacetonitrile hydrochloride;
A3 2-(2-thienyl)aminoacetonitrile hydrochloride;

Method B**2-(2,6-Dichlorobenzamido)-2-propoxyacetamide**

20 A solution of 2,6-dichlorobenzoyl chloride (5 ml) in dichloromethane (5 ml) was added dropwise to a stirred mixture of aminoacetonitrile hydrogen sulphate (5.38 g), dichloromethane (75 ml) and triethylamine (17.5 ml) keeping the temperature below 30°C. The mixture was stirred at ambient temperature for 16 hours then washed successively with water and brine, dried and evaporated to dryness under reduced pressure. The residue was
25 purified by flash chromatography using 1% methanol in dichloromethane as eluent to give 2-(2,6-dichlorobenzamido)acetonitrile (6.26 g). Mp 130-134°C; m/z 229 (MH⁺).

A mixture of 2-(2,6-dichlorobenzamido)acetonitrile (2 g), glacial acetic acid (15 ml) and bromine (0.45 ml) was stirred in a bath at 50°C until the solution had decolourised. The mixture was cooled and the insoluble solid collected and washed with dichloromethane to give

2-(2,6-dichlorobenzamido)-2-bromoacetamide (1.43 g), which was used without further purification.

A mixture of 2-(2,6-dichlorobenzamido)-2-bromoacetamide (700 mg) and *n*-propanol (4 ml) was heated at 90°C for 5 min and then evaporated to dryness under reduced pressure.

- 5 The residue was partitioned between chloroform and aqueous sodium hydrogen carbonate, and the organic phase was dried and evaporated to dryness under reduced pressure to give 2-(2,6-dichlorobenzamido)-2-propoxyacetamide (370 mg). M/z 287 (MH^+) which was used without further purification.

Methods B 1-2

- 10 Using a process similar to that described in Method C using the appropriate alcohol there was prepared:

B1 2-(2,6-dichlorobenzamido)-2-ethoxyacetamide. M/z 291 (MH^+);

B2 2-(2,6-dichlorobenzamido)-2-methoxyacetamide. M/z 277 (MH^+).

Methods B 3-10

- 15 By a process similar to that described in preparation of the intermediate for Method C but using tetrahydrofuran as solvent instead of excess alcohol there was prepared:

2-(2,6-dichlorobenzamido)-2-(3-phenylprop-2-ynyloxy)acetamide. M/z 377 (MH^+);

2-(2,6-dichlorobenzamido)-2-(3-phenylprop-2-enyloxy)acetamide. M/z 379 (MH^+);

2-(2,6-dichlorobenzamido)-2-(2-morpholinoethoxy)acetamide. M/z 376 (MH^+);

- 20 2-(2,6-dichlorobenzamido)-2-ethylthioacetamide. M/z 307 (MH^+);

2-(2,6-dichlorobenzamido)-2-(2-propynyl)oxyacetamide. M/z 300 (M^+);

2-(2,6-dichlorobenzamido)-2-methylthioacetamide. M/z 293 (MH^+);

2-(2,6-dichlorobenzamido)-2-[(2-pyridyl)methoxy]acetamide. M/z 354 (MH^+);

2-(2,6-dichlorobenzamido)-2-(2,2,2-trifluoroethoxy)acetamide. M/z 345 (MH^+).

25 **Method C**

2-(2,6-Dichlorobenzamido)-2-(3,5-dimethylpyrazol-1-yl)acetamide

- A mixture of 2-(2,6-dichlorobenzamido)-2-bromoacetamide (500 mg), pyridine (4 ml) and 3,5-dimethylpyrazole (442 mg) was heated at 90°C for 5 min and then cooled and diluted to 60 ml with water. The mixture was extracted with ethyl acetate and the organic phase was washed with water, dried and evaporated to dryness under reduced pressure. The residue was

triturated with ether and the insoluble solid collected to give 2-(2,6-dichlorobenzamido)-2-(3,5-dimethylpyrazol-1-yl)acetamide (227 mg). M/z 341 (MH⁺).

Method C1

Using a process similar to that described in Method C using pyrazole instead of 3,5-dimethylpyrazole there was prepared:

C1 2-(2,6-dichlorobenzamido)-2-(pyrazol-1-yl)acetamide M/z 313 (MH⁺).

Method D

2-Benzotriazol-1-yl-2-(2,6-dichlorobenzamido)acetamide

A mixture of 2,6-dichlorobenzamide (3 g), ethyl glyoxalate (4 g), benzotriazole (2.8 g), para-toluenesulphonic acid (0.2 g) and toluene (100 ml) was heated at reflux in a flask fitted with a Dean and Stark trap for 5 hours. The mixture was evaporated to dryness under reduced pressure and the residue purified by medium pressure liquid chromatography using 0.5 - 1% methanol in dichloromethane as eluent to give ethyl 2-benzotriazol-1-yl-2-(2,6-dichlorobenzamido)acetate (1.18 g). Mp 194-195°C; m/z 393 (MH⁺).

15 A mixture of ethyl 2-benzotriazol-1-yl-2-(2,6-dichlorobenzamido)acetate (350 mg) and a saturated solution of ammonia in ethanol (8 ml) was stirred at 0°C for 0.5 hours then kept at 4°C for 18 hours. The solid which had precipitated was collected to give 2-benzotriazol-1-yl-2-(2,6-dichlorobenzamido)acetamide (55 mg). M/z 364 (MH⁺).

Method E

2-Acetamido-2-(2,6-dichlorobenzamido)acetamide

The filtrate from the above experiment was evaporated to dryness under reduced pressure and the residue was dissolved in a saturated solution of ammonia in ethanol (8 ml) and the solution was kept at ambient temperature for 60 hours. The solution was evaporated to dryness under reduced pressure, the residue was triturated with ether and the insoluble solid collected to give 2-amino-2-(2,6-dichlorobenzamido)acetamide (148 mg).

25 A mixture of 2-amino-2-(2,6-dichlorobenzamido)acetamide (120 mg), N,N-dimethylformamide (2 ml) and pentafluorophenylacetate (310 mg) was stirred at ambient temperature for 1 hour. The mixture was treated with water and ethyl acetate and the insoluble solid collected to give 2-acetamido-2-(2,6-dichlorobenzamido)acetamide (87 mg). M/z 304 (MH⁺).

Method F2-(1-Bromo-2-naphthoylamino)-2-isopropylthioacetamide

A mixture of 1-bromo-2-naphthoic acid (1.75 g), dichloromethane (20 ml) and oxalyl chloride (0.9 ml) was stirred while adding *N,N*-dimethylformamide (0.05 ml), the mixture was 5 stirred a further 1 hour and then evaporated to dryness. The residual acid chloride was stirred with concentrated aqueous ammonia at for 1 hour and the insoluble solid was collected and washed with water to give 1-bromo-2-naphthoylamide (1.67 g), which was used without further purification.

A mixture of 1-bromo-2-naphthoylamide (750 mg), glyoxilic acid monohydrate (304 10 mg) and acetone (5 ml) was stirred at reflux for 3 hours and the resulting solution was evaporated to dryness under reduced pressure. A mixture of the residue, isopropanethiol (0.38 g), dichloroethane (10 ml) and 2-naphthalenesulphonic acid (30 mg) was stirred at reflux for 4 hours and the resulting solution was evaporated to dryness under reduced pressure. A mixture of the residue, methanol (30 ml) and concentrated sulphuric acid (2 ml) was stirred at ambient 15 temperature for 2 hours. The solution was poured into a stirred mixture of ice and saturated sodium bicarbonate solution and the mixture was extracted with diethyl ether. The extracts were washed with brine, dried and evaporated to dryness under reduced pressure and the residue was purified by flash chromatography using increasingly polar mixtures of ethylacetate and hexane as eluent to give ethyl 2-(1-bromo-2-naphthoylamino)-2-isopropylthioacetate (550 20 mg). M/z 396 (MH^+).

A mixture of ethyl 2-(1-bromo-2-naphthoylamino)-2-isopropylthioacetate (520 mg), methanol (10 ml) and concentrated aqueous ammonia was stirred at ambient temperature for 3 hours. The solution was diluted with water and the precipitate collected to give 2-(1-bromo-2-naphthoylamino)-2-isopropylthioacetamide (450 mg). Mp 119-120°C; m/z 381 (MH^+).

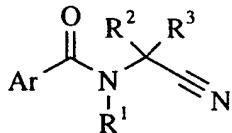
25 **Method F1**

By a procedure analogous to the procedure described in Method F and using the appropriate starting materials, there was prepared:

F1: 2-(2,4-dichlorobenzamido)-2-isopropylthioacetamide. M/z 321 (MH^+).

CLAIMS

1. A compound of formula (I):



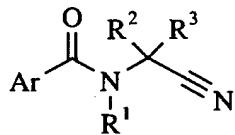
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(I)

wherein **Ar** is (optionally substituted phenylC₁₋₆alkyl)₂CH-, optionally substituted phenyl, optionally substituted naphthyl or an optionally substituted heteroaryl ring, said optional substituents being chosen from one or more of halo, C₁₋₆alkoxy, C₁₋₆alkyl, nitro, C₁₋₆alkanoylamino, trifluoromethyl, hydroxy, trifluoromethoxy, cyano, C₁₋₆alkanoyl, C₁₋₆alkanoyloxy, amino, C₁₋₆alkylamino, (C₁₋₆alkyl)₂amino, carboxy, carbamoyl, N-(C₁₋₆alkyl)carbamoyl, N,N-(C₁₋₆alkyl)₂carbamoyl, C₁₋₆alkoxycarbonyl, mercapto, C₁₋₆alkylsulphanyl, C₁₋₆alkylsulphinyll, C₁₋₆alkylsulphonyl, sulphamoyl, N-(C₁₋₆alkyl)sulphamoyl, N,N-(C₁₋₆alkyl)₂sulphamoyl, aminoC₁₋₆alkyl, N-(C₁₋₆alkyl)aminoC₁₋₆alkyl, (C₁₋₆alkyl)₂aminoC₁₋₆alkyl, R⁵S-, R⁵C(O)- or R⁵CH₂-; R⁵ is phenyl which is optionally substituted by one or more groups chosen from C₁₋₆alkyl, halo, trifluoromethyl, hydroxy, trifluoromethoxy, cyano, C₁₋₆alkoxy, C₁₋₆alkanoyl, C₁₋₆alkanoyloxy, amino, C₁₋₆alkylamino, (C₁₋₆alkyl)₂amino, C₁₋₆alkanoylamino, nitro, carboxy, carbamoyl, N-(C₁₋₆alkyl)carbamoyl, N,N-(C₁₋₆alkyl)₂carbamoyl, C₁₋₆alkoxycarbonyl, mercapto, C₁₋₆alkylsulphanyl, C₁₋₆alkylsulphinyll, C₁₋₆alkylsulphonyl, sulphamoyl, N-(C₁₋₆alkyl)sulphamoyl or N,N-(C₁₋₆alkyl)₂sulphamoyl; R¹ is H or C₁₋₆alkyl; R² is H, C₁₋₆alkyl (optionally substituted with one or more hydroxy, C₁₋₆alkylsulphanyl, C₁₋₆alkylsulphinyll, C₁₋₆alkylsulphonyl, R⁴, R⁴C₁₋₆alkylsulphanyl, R⁴C₁₋₆alkylsulphinyll or R⁴C₁₋₆alkylsulphonyl), C₁₋₆alkoxy (optionally substituted with one or more halogen, C₂₋₆alkenyl, C₂₋₆alkynyl, R⁴, R⁴C₂₋₆alkenyl, R⁴C₂₋₆alkynyl or Het), C₂₋₆alkenyl, C₂₋₆alkynyl, C₁₋₆alkoxycarbonyl, carbamoyl, N-(C₁₋₆alkyl)carbamoyl, N,N-(C₁₋₆alkyl)₂carbamoyl, R⁴-, R⁴S-, R⁴C₁₋₆alkylsulphanyl, N-(R⁴C₁₋₆alkyl)carbamoyl, N-(HetC₁₋₆alkyl)carbamoyl, C₁₋₆alkanoylamino, C₁₋₆alkylsulphanyl, C₁₋₆alkylsulphinyll

or C₁₋₆alkylsulphonyl; R⁴ is optionally substituted phenyl, or an optionally substituted 5 or 6 membered heteroaryl ring, said optional substituents on R⁴ being chosen from one or more of C₁₋₆alkyl, halo, trifluoromethyl, hydroxy, trifluoromethoxy, cyano, C₁₋₆alkoxy, C₁₋₆alkanoyl, C₁₋₆alkanoyloxy, amino, C₁₋₆alkylamino, (C₁₋₆alkyl)₂amino, 5 C₁₋₆alkanoylamino, nitro, carboxy, carbamoyl, N-(C₁₋₆alkyl)carbamoyl, N,N-(C₁₋₆alkyl)₂carbamoyl, C₁₋₆alkoxycarbonyl, mercapto, C₁₋₆alkylsulphanyl, C₁₋₆alkylsulphinyl, C₁₋₆alkylsulphonyl, sulphamoyl, N-(C₁₋₆alkyl)sulphamoyl or 10 N,N-(C₁₋₆alkyl)₂sulphamoyl, wherein two such adjacent groups may join to form a 6-membered saturated, partially saturated or unsaturated ring; Het is a fully saturated monocyclic 5 - 8 membered heterocyclic ring, with up to 4 ring heteroatoms; and, R³ is 10 H or C₁₋₆alkyl; or a pharmaceutically acceptable salt thereof.

2. A compound of formula (I):



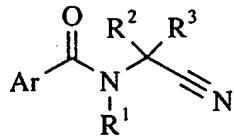
(I)

wherein Ar is phenyl substituted with 1 to 3 chloro or methyl moieties, or naphthyl substituted with 1 bromo atom; R¹ is H or C₁₋₆alkyl; R² is H, C₁₋₆alkyl (optionally substituted with one or more hydroxy, C₁₋₆alkylsulphanyl, C₁₋₆alkylsulphinyl, C₁₋₆alkylsulphonyl, R⁴, R⁴C₁₋₆alkylsulphanyl, R⁴C₁₋₆alkylsulphinyl or 20 R⁴C₁₋₆alkylsulphonyl), C₁₋₆alkoxy (optionally substituted with one or more halogen, C₂₋₆alkenyl, C₂₋₆alkynyl, R⁴, R⁴C₂₋₆alkenyl, R⁴C₂₋₆alkynyl or Het), C₂₋₆alkenyl, C₂₋₆alkynyl, C₁₋₆alkoxycarbonyl, carbamoyl, N-(C₁₋₆alkyl)carbamoyl, N,N-(C₁₋₆alkyl)₂carbamoyl, R⁴-S-, R⁴C₁₋₆alkylsulphanyl, N-(R⁴C₁₋₆alkyl)carbamoyl, N-(HetC₁₋₆alkyl)carbamoyl, C₁₋₆alkanoylamino, C₁₋₆alkylsulphanyl, C₁₋₆alkylsulphinyl or C₁₋₆alkylsulphonyl; R⁴ is optionally substituted phenyl, or an optionally substituted 5 or 6 membered heteroaryl ring, said optional substituents on R⁴ being chosen from one or more of C₁₋₆alkyl, halo, trifluoromethyl, hydroxy, trifluoromethoxy, cyano, C₁₋₆alkoxy, C₁₋₆alkanoyl, C₁₋₆alkanoyloxy, amino, C₁₋₆alkylamino, (C₁₋₆alkyl)₂amino, 25 C₁₋₆alkanoylamino, nitro, carboxy, carbamoyl, N-(C₁₋₆alkyl)carbamoyl, N,N-(C₁₋₆alkyl)₂carbamoyl, C₁₋₆alkoxycarbonyl, mercapto, C₁₋₆alkylsulphanyl, C₁₋₆alkylsulphinyl or C₁₋₆alkylsulphonyl, sulphamoyl, N-(C₁₋₆alkyl)sulphamoyl or N,N-(C₁₋₆alkyl)₂sulphamoyl, wherein two such adjacent groups may join to form a 6-membered saturated, partially saturated or unsaturated ring; Het is a fully saturated monocyclic 5 - 8 membered heterocyclic ring, with up to 4 ring heteroatoms; and, R³ is H or C₁₋₆alkyl; or a pharmaceutically acceptable salt thereof.

C₁₋₆alkanoylamino, nitro, carboxy, carbamoyl, N-(C₁₋₆alkyl)carbamoyl, N,N-(C₁₋₆alkyl)₂carbamoyl, C₁₋₆alkoxycarbonyl, mercapto, C₁₋₆alkylsulphanyl, C₁₋₆alkylsulphinyl, C₁₋₆alkylsulphonyl, sulphamoyl, N-(C₁₋₆alkyl)sulphamoyl or N,N-(C₁₋₆alkyl)₂sulphamoyl, wherein two such adjacent groups may join to form a 6-membered saturated, partially saturated or unsaturated ring; Het is a fully saturated monocyclic 5 - 8 membered heterocyclic ring, with up to 4 ring heteroatoms; and, R³ is H or C₁₋₆alkyl; or a pharmaceutically acceptable salt thereof; provided that when R¹, R² and R³ are all hydrogen then Ar is not 4-chlorophenyl.

- 10 3. A compound as claimed in claim 2 wherein R¹ is hydrogen.
4. A compound as claimed in claim 2 or 3 wherein R³ is hydrogen.
5. A compound as claimed in claim 2, 3 or 4 wherein R² is hydrogen, C₁₋₆alkoxy (optionally substituted with one or more halogen, C₂₋₆alkynyl, R⁴, R⁴C₂₋₆alkenyl, R⁴C₂₋₆alkynyl or Het), C₁₋₆ alkanoylamino, C₁₋₆ alkylsulphanyl or R⁴; R⁴ is optionally substituted phenyl or an optionally substituted 5 or 6 membered heteroaryl ring said optional substituents being chosen from one or more C₁₋₆ alkyl groups, wherein two such adjacent groups may join to form a 6-membered saturated, partially saturated or unsaturated ring; Het is a fully saturated monocyclic 5 - 8 membered heterocyclic ring, with up to 4 ring heteroatoms.
- 20 6. A compound as claimed in any one of claims 2 to 5 wherein R² is hydrogen, methoxy, ethoxy, propoxy, 3-phenylprop-2-nyloxy, 3-phenylprop-2-enyloxy, 2-morpholinoethoxy, acetamido, 2,2,2-trifluoroethoxy, methylthio, ethylthio, iso-propylthio, 2-propynloxy, pyridylmethoxy, optionally substituted pyrazolyl, optionally substituted triazolyl, optionally substituted furyl, optionally substituted thienyl where said optional substituents are chosen from 1 or 2 methyl groups or said 5-membered ring is fused to a benzene ring (to form, for example, a benzotriazolyl bicyclic ring system).

7. A pharmaceutical composition comprising a compound of formula (I) as claimed in claim 1 or 2 and a pharmaceutically acceptable diluent or carrier.
- 5 8. A compound of formula (I):



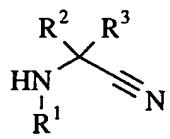
(I)

wherein Ar is (optionally substituted phenylC₁₋₆alkyl)₂CH-, substituted phenyl (but not phenyl substituted only with nitro) or optionally substituted naphthyl, said optional substituents being chosen from one or more of halo, C₁₋₆alkoxy, C₁₋₆alkyl, nitro, 10 C₁₋₆alkanoylamino, trifluoromethyl, hydroxy, trifluoromethoxy, cyano, C₁₋₆alkanoyl, C₁₋₆alkanoyloxy, amino, C₁₋₆alkylamino, (C₁₋₆alkyl)₂amino, carboxy, carbamoyl, N-(C₁₋₆alkyl)carbamoyl, N,N-(C₁₋₆alkyl)₂carbamoyl, C₁₋₆alkoxycarbonyl, mercapto, C₁₋₆alkylsulphanyl, C₁₋₆alkylsulphiny, C₁₋₆alkylsulphonyl, sulphamoyl, 15 N-(C₁₋₆alkyl)sulphamoyl, N,N-(C₁₋₆alkyl)₂sulphamoyl, aminoC₁₋₆alkyl, N-(C₁₋₆alkyl)aminoC₁₋₆alkyl, (C₁₋₆alkyl)₂aminoC₁₋₆alkyl, R⁵S-, R⁵C(O)- or R⁵CH₂-; R⁵ is phenyl which is optionally substituted by one or more groups chosen from C₁₋₆alkyl, halo, trifluoromethyl, hydroxy, trifluoromethoxy, cyano, C₁₋₆alkoxy, C₁₋₆alkanoyl, 20 C₁₋₆alkanoyloxy, amino, C₁₋₆alkylamino, (C₁₋₆alkyl)₂amino, C₁₋₆alkanoylamino, nitro, carboxy, carbamoyl, N-(C₁₋₆alkyl)carbamoyl, N,N-(C₁₋₆alkyl)₂carbamoyl, C₁₋₆alkoxycarbonyl, mercapto, C₁₋₆alkylsulphanyl, C₁₋₆alkylsulphiny, C₁₋₆alkylsulphonyl, sulphamoyl, N-(C₁₋₆alkyl)sulphamoyl or 25 N,N-(C₁₋₆alkyl)₂sulphamoyl; R¹ is H or C₁₋₆alkyl; R² is H, C₁₋₆alkyl (optionally substituted with one or more hydroxy, C₁₋₆alkylsulphanyl, C₁₋₆alkylsulphiny, C₁₋₆alkylsulphonyl, R⁴, R⁴C₁₋₆alkylsulphanyl, R⁴C₁₋₆alkylsulphiny or R⁴C₁₋₆alkylsulphonyl), C₁₋₆alkoxy (optionally substituted with one or more halogen, C₂₋₆alkenyl, C₂₋₆alkynyl, R⁴, R⁴C₂₋₆alkenyl, R⁴C₂₋₆alkynyl or Het), C₂₋₆alkenyl, C₂₋₆alkynyl, C₁₋₆alkoxycarbonyl, carbamoyl, N-(C₁₋₆alkyl)carbamoyl,

N,N-(C₁₋₆alkyl)₂carbamoyl, R⁴-, R⁴S-, R⁴C₁₋₆alkylsulphanyl, N-(R⁴C₁₋₆alkyl)carbamoyl, N-(HetC₁₋₆alkyl)carbamoyl, C₁₋₆alkanoylamino, C₁₋₆alkylsulphanyl, C₁₋₆alkylsulphinyl or C₁₋₆alkylsulphonyl; R⁴ is optionally substituted phenyl, or an optionally substituted 5 or 6 membered heteroaryl ring, said optional substituents on R⁴ being chosen from one or more of C₁₋₆alkyl, halo, trifluoromethyl, hydroxy, trifluoromethoxy, cyano, C₁₋₆alkoxy, C₁₋₆alkanoyl, C₁₋₆alkanoyloxy, amino, C₁₋₆alkylamino, (C₁₋₆alkyl)₂amino, C₁₋₆alkanoylamino, nitro, carboxy, carbamoyl, N-(C₁₋₆alkyl)carbamoyl, N,N-(C₁₋₆alkyl)₂carbamoyl, C₁₋₆alkoxycarbonyl, mercapto, C₁₋₆alkylsulphanyl, C₁₋₆alkylsulphinyl, C₁₋₆alkylsulphonyl, sulphamoyl, N-(C₁₋₆alkyl)sulphamoyl or N,N-(C₁₋₆alkyl)₂sulphamoyl, wherein two such adjacent groups may join to form a 6-membered saturated, partially saturated or unsaturated ring; Het is a fully saturated monocyclic 5 - 8 membered heterocyclic ring, with up to 4 ring heteroatoms; and, R³ is H or C₁₋₆alkyl; or a pharmaceutically acceptable salt thereof; for use as a medicament.

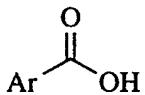
- 15 9. The use of a compound of formula (I) as claimed in claim 1 or 2, or a pharmaceutically acceptable salt thereof, in the manufacture of a medicament for use in the inhibition of a cysteine protease in a warm blooded animal.
- 10 10. The use of a compound of formula (I) as claimed in claim 1 or 2, or a pharmaceutically acceptable salt thereof, in the manufacture of a medicament for use in the treatment of chronic obstructive pulmonary disease in a warm blooded animal.
- 20 11. A method of treating a Cathepsin L or Cathepsin S mediated disease state in mammals which comprises administering to a mammal in need of such treatment an effective amount of a compound of formula (I) as claimed in claim 1 or 2, or a pharmaceutically acceptable salt thereof.
- 25 12. A process for preparing a compound of formula (I) as claimed in claim 1 or 2, the process comprising:

a) reacting an amine of formula (II)



(II)

with an acid of formula (III)

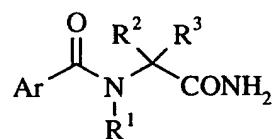


(III)

or a reactive derivative thereof;

or,

b) dehydrating an amide of formula (IV)

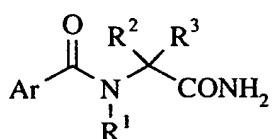


(IV)

under standard conditions;

wherein Ar, R¹, R² and R³ are as defined in claim 1.

15 13. An intermediate compound of formula (IV):



(IV)

wherein Ar, R¹, R² and R³ are as defined in claim 1.

INTERNATIONAL SEARCH REPORT

Int'l. Jonal Application No
PCT/GB 00/00539

A. CLASSIFICATION OF SUBJECT MATTER

IPC 7	C07C255/29	C07C255/25	C07D307/54	C07D231/12	C07D295/08
	C07C323/60	A61K31/275	A61K31/33	A61P19/00	C07D333/24
	C07D249/18				

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 C07C C07D A61K A61P

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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Further documents are listed in the continuation of box C.

Patent family members are listed in annex.

* Special categories of cited documents :

- "A" document defining the general state of the art which is not considered to be of particular relevance
- "E" earlier document but published on or after the international filing date
- "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- "O" document referring to an oral disclosure, use, exhibition or other means
- "P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the International filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search

9 May 2000

Date of mailing of the international search report

23/05/2000

Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,
Fax: (+31-70) 340-3016

Authorized officer

Pauwels, G

INTERNATIONAL SEARCH REPORT

Inte	ional Application No
PCT/GB 00/00539	

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	T UEDA ET AL: "Syntheses of 2-acylaminoacetamidine and 3-acylamino propionamidine derivatives" CHEMICAL AND PHARMACEUTICAL BULLETIN, JP, TOKYO, vol. 12, no. 16, 1 January 1968 (1968-01-01), pages 2355-2361, XP002075777 ISSN: 0009-2363 page 2356; table I ---	1-6,8,12
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X	M. SEDLAK ET AL. : "Preparation, 1H and 13C NMR spectra of substituted 2-benzoylaminocarboxamides" COLLECTION OF CZECHOSLOVAK CHEMICAL COMMUNICATIONS, vol. 60, 1995, pages 150-160, XP002136842 PRAGUE CS page 151; figure III; table III ---	13
X	H. BRACHWITZ: "1,2,4-oxadiazole aus N-Acylaminonitrile" JOURNAL F. PRAKT. CHEMIE, vol. 314, no. 3, - 1972 pages 447-454, XP000908890 page 448; examples 4A-D ---	1-6,12
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INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/GB 00/00539

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